T15D13 – (Part 15.4) Spontaneity

Name _____

1. 15.4.1 Predict whether a reaction or process will be spontaneous by using the sign of ΔG. (3)
   a. What is a spontaneous reaction?

   b. Some spontaneous processes need initiation, others do not, give examples of each:

   c. How fast to spontaneous processes occur?

   d. What is a non-spontaneous reaction? Examples?

   e. What is the equation for Gibbs free energy? What do the Gibbs free values mean?

Equation for Gibbs Free Energy	When ΔG is negative	When ΔG is positive	When ΔG is zero

   f. Example: Calculate the Gibbs free energy change for the following reaction under standard state conditions
   $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
   $\Delta H^\theta = -95.4 \frac{kJ}{mol}$
   $\Delta S^\theta = -198.3 \frac{J}{K\ mol}$
   T = 298K

      i. If you wanted to calculate the temperature above which the reaction ceases to occur spontaneously

   g. What does free energy mean?

   h. Example: Calculate the entropy change of the surroundings when water condenses on a window at 25°C T
   $H_2O\ (g) \rightarrow H_2O\ (l)$
   $\Delta H^\theta = -44.0 \frac{kJ}{mol}$
   $\Delta S^\theta_{system} = -118 \frac{J}{K\ mol}$

2. 15.4.2 Calculate ΔG for a reaction using the equation ΔG= ΔH−TΔS and by using values of the standard free energy change of formation, ΔGf . (2)
   a. What does a positive and negative value for ΔG^θ_f mean?

	Stability	Result
ΔG^θ_f is negative		
ΔG^θ_f is positive		

   b. What is the equation for Gibbs free energy of reaction?

c. Use the following Gibbs free energy change of formation, ΔG^{θ}_{f}, for the decomposition of magnesium carbonate

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

$\Delta G^{\theta}_{f}[MgCO_3(s)] = -1012 \frac{kJ}{mol}$

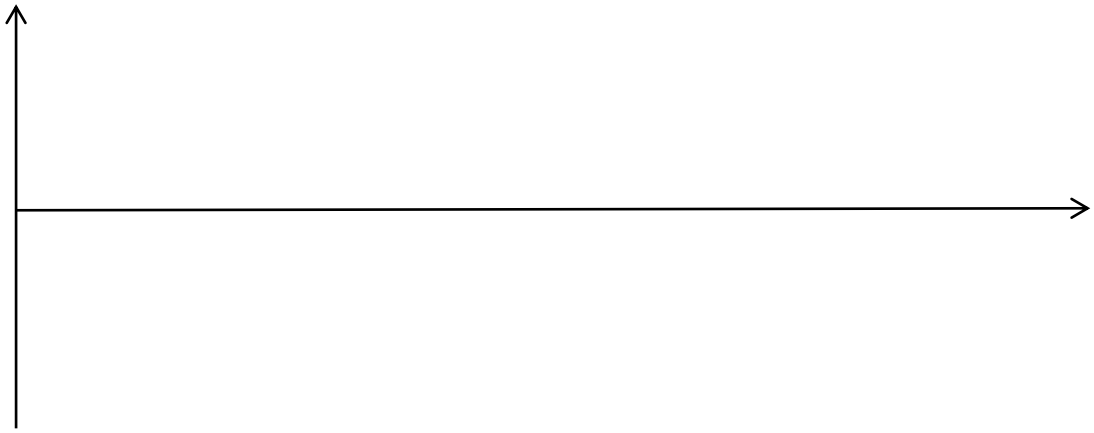
$\Delta G^{\theta}_{f}[MgO(s)] = -569 \frac{kJ}{mol}$

$\Delta G^{\theta}_{f}[CO_2(g)] = -394 \frac{kJ}{mol}$

3. 15.4.3 Predict the effect of a change in temperature on the spontaneity of a reaction using standard entropy and enthalpy changes and the equation $\Delta G = \Delta H - T\Delta S$. (3)
   a. Positive entropy values help drive a reaction
   b. Negative enthalpy values help drive a reaction

Enthalpy Change ΔH	Entropy Change ΔS	Gibbs Free energy Change ΔG	Spontaneity

   c. Draw a diagram to represent this effect:



   d. Examples of calculations are provided on the power point, feel free to copy down as a reference